



## Article

# Satisfaction Evaluation for Underpass Green Spaces in Mountainous Cities under the Perspective of Environmental Perception

Junjie Zhang <sup>1</sup> , Junji Liu <sup>1</sup> , Hong Yang <sup>2</sup>, Junping Quan <sup>2,\*</sup>, Li Wang <sup>2</sup>, Qixiao He <sup>1</sup> and Fanmiao Li <sup>3</sup>

<sup>1</sup> College of Architecture and Urban Planning, Chongqing Jiaotong University, Chongqing 400074, China; junjieliuzhou@163.com (J.Z.); 18323836248@163.com (J.L.); hqx623@cqjtu.edu.cn (Q.H.)

<sup>2</sup> Nanshan Botanical Garden Management Office, Chongqing 400065, China

<sup>3</sup> China Building Technology Group Co., Ltd., Beijing 100013, China; 15321052660@163.com

\* Correspondence: 990201900073@cqjtu.edu.cn; Tel.: +86-189-9615-1362

**Abstract:** The overpasses and the terrain under them in Chongqing, a mountainous city in China, are complex and diverse, and some spaces under the overpasses are integrated and reconstructed into the underpass green space for citizens to stroll about or have a rest. From the perspective of visitor perception, this paper constructs a perception evaluation system of the environmental characteristics of underpass green space in mountainous cities from the following five environmental perception dimensions: path organization, security, aesthetic value, physical environment, activities and cultural. The IPA-Kano model is used to quantify environmental perception, and the main environmental factors affecting the improvement of recreation satisfaction of underpass green space in three types of terrain are explored, with a view to improving the environment and service functions of underpass green spaces in high-density interchange networks in mountainous cities, and enhancing the attractiveness of underpass green spaces. It can be found from the study that: (1) Among the five environmental perception dimensions, visitors pay more attention to the physical environment quality of the underpass green space and their physical and psychological activity experience, while their demands for visual senses are relatively low. Due to the deficiency or lack of leisure facilities, sports facilities, children's playgrounds and amusement equipment, the dimension of "activities and cultural perception" of the underpass green space has the lowest scores of all. (2) The existing sites, facilities and landscape resources of the underpass green space, different terrain types and underpass environment are the important reasons that affect the performance of environmental perception factors and their priority ranking results. (3) The improvement of security of the arrival path or sports facilities is beneficial to improve visitor satisfaction of underpass green space of three types of terrain. The number of environmental factors to be optimized of the three types of terrain are ranked as: mountainous green space > flat green space > concave green space. Among them, four environmental factors have a high priority in two kinds of underpass green space, which are the distribution and quantity of leisure facilities, the effect of noise reduction and sound insulation, the adequacy of activity venues and the distribution and quantity of sports facilities. Finally, according to the particularity of the underpass environment and the characteristics of three types of terrain, this paper puts forward some suggestions for optimizing the service function of underpass green space from five perceptual dimensions.

**Keywords:** overpass; overpass shadow land; recreation satisfaction; perceptual quality; IPA-Kano model; Chongqing



**Citation:** Zhang, J.; Liu, J.; Yang, H.; Quan, J.; Wang, L.; He, Q.; Li, F. Satisfaction Evaluation for Underpass Green Spaces in Mountainous Cities under the Perspective of Environmental Perception. *Buildings* **2023**, *13*, 1489. <https://doi.org/10.3390/buildings13061489>

Academic Editor: Daniele Torreggiani

Received: 7 March 2023

Revised: 7 May 2023

Accepted: 4 June 2023

Published: 9 June 2023



**Copyright:** © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

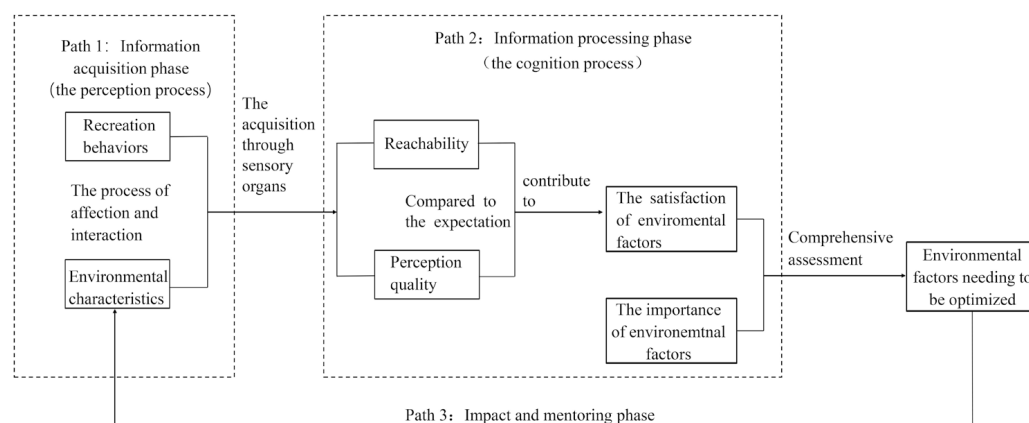
## 1. Introduction

Nowadays, the city space environment tends to be in a state of high-density development and compactness. In addition to the urban environment, there is growing public concern about life quality and neighborhood relations. How to use urban land intensively and improve the quality of public space both scientifically and efficiently have become

urgent issues. As a derivative of relieving traffic pressure in urban development, the overpass separates the original ecological structure, function region connections and pedestrian space network of the city [1]. The attached space under the overpass is a space enclosed by the orthographic projection area of the overpass (overpass shadow land), involving areas between the ramps and areas between ramps and surrounding urban roads [2]. The overpasses in mountainous cities are often composed of three-dimensional transportation, such as river-crossing bridges, overpass roads, elevated tracks and railways. The overpass shadow land in mountainous cities often contains side slopes, retaining walls, cliffs, concave grounds and other terrains that are more complex and difficult to exploit than those of other cities [3]. At present, in order to optimize and adjust the utilization types of idle lands, revitalize the stock of inefficient land-use resources, and improve the stiff urban appearance of high-density built-up areas, some mountainous cities integrate and reconstruct some “lost space” under overpasses, and make it into affiliated underpass green space shared by the public (hereinafter referred to as “underpass green space”) according to local conditions. This kind of underpass green space can not only improve the environment, but also provide the residents nearby with green open spaces for leisure, communication, entertainment and fitness, and enhance their happiness in life.

Satisfaction comes from the comparison between people’s actual perception and their expectations. In the 1970s and 1980s, this target was used to measure the satisfaction degree of customers or visitors in product marketing and tourism [4,5]. Environmental perception has been considered the key variable of satisfaction evaluation in a large number of studies [6]. It refers to the impression formed in people’s minds by their subjective feelings and psychological judgments about the natural and social environment surrounding them [7–9]. Since 2000, environmental perception has been commonly used to reflect satisfaction-related issues, such as the attractiveness of tourist destinations, the quality of the tourism environment [10,11], consumption and shopping [12], etc. Environmental perception is often used as an important medium for satisfaction evaluation. After people experience the recreation, their satisfaction feedback on each evaluation element is often used for environmental perception measurement [13]. In recent years, the research on environmental perception has been extended to residents’ subjective perception of their surrounding ecology or landscape environment, such as research on the visitors’ environmental perception of national parks, scenic spots, specific parks, urban parks, treetop walks and other green spaces [14–18]. These studies often categorize the factors of visitors’ environmental perception according to the nature of green spaces and the characteristics of visitors’ recreation, which provide suggestions for the optimization of the ecological environment, landscape quality, and recreation experience. As a result, people’s living quality can be improved as well.

Gold and Burnett, respectively, have explained the process of environmental perception from a psychological point of view [19,20]. With comprehensive reference to previous theories, this paper interprets the environmental perception process. In the process of influence and interaction between recreational behavior and environmental characteristics, with information such as the accessibility and perceptual quality of the site obtained through perceptual organs, site users compare what they obtain with their expected environment [5], then stimulate the psychological perception activities in the brain, and produce the satisfaction of each environmental perception factor. Then, the users superimpose satisfaction with the importance of perception factors and comprehensively evaluate the environmental factors that need to be optimized on the site. This environmental perception process is therefore referred to in the influencing and guiding the optimization of the overall environmental characteristics of the site [7,19,21,22]. Therefore, the process of environmental perception can be divided into three stages: obtaining information, processing information, and influencing and guiding (Figure 1).



**Figure 1.** Schematic of environmental perception process.

Some scholars have studied the environmental quality of underpass green space in mountainous cities from the perspective of planning designers. For instance, Zhang Shuaijie put forward the renewal strategy of the overpass shadow land of overpasses in the riverside areas of Chongqing, from the perspective of environmental behavior studies [23]. However, there are often deviations between planning designers and all kinds of visitors on the green space function and space preference. There is a lack of evaluation system of underpass green spaces from the perspective of recreation in the previous literature. Additionally, there is a lack of comparison and quantitative research on the recreation space quality of different types of underpass green space, which are the advantages of satisfaction evaluation from the perspective of environmental perception. Therefore, it is of necessity to construct a perception evaluation system of the environmental characteristics of underpass green space in mountainous cities from the perspective of visitors' perception. The Importance and Performance Analysis and three-factor theory are applied in the qualification of the environmental perception. During this process, the main environmental factors that affect the recreation satisfaction of underpass green space in three different terrains are explored, in order to provide reference measures for the adaptive reuse of the inventory space under the overpass, highlight the regional characteristics of mountainous cities with high-density overpass networks, and enhance the attraction and service quality of underpass green spaces.

## 2. Data and Methodology

### 2.1. Study Area

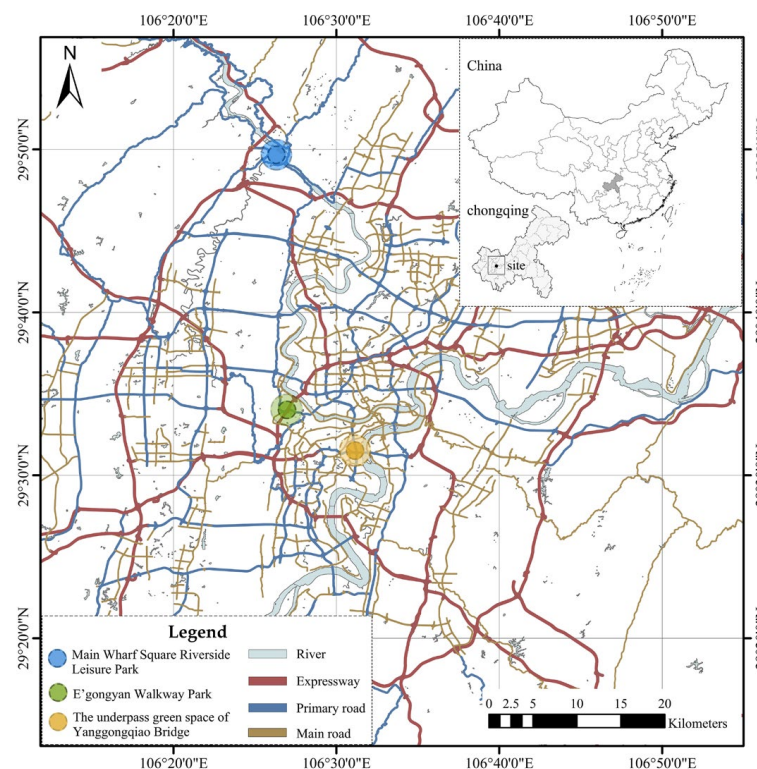
Chongqing ( $28^{\circ}10' \sim 32^{\circ}13' \text{ N}$ ,  $105^{\circ}11' \sim 110^{\circ}11' \text{ E}$ ) is the provincial administrative region of the People's Republic of China. It is located in the southwest of China and the upper reaches of the Yangtze River. The landscape is dominated by hills and mountains, of which the mountains account for 76%, known as the "City of Mountains", and there are many rivers, complex and diverse terrain, with a network of crisscrossing interchanges.

Recreation satisfaction is significantly affected by various environmental characteristics [13]. Three underpass green spaces with many surrounding residential areas are selected as research cases: a high utilization rate of residents and perfect living facilities, but different topographic characteristics and the surrounding environment (Table 1 and Figure 2). Sample 1 is Main Wharf Square Riverside Leisure Park (Figure 3, hereinafter referred to as "Main Wharf Park"), which is a comprehensive riverside park with relatively complete facilities located under the ramps of Beidong Jialing River Bridge in Beibei District. Sample 2 is E'gongyan Walkway Park in Jiulongpo District (Figure 4, namely the underpass green space of E'gongyan overpass, hereinafter referred to as "E'gongyan Park"), which is Chongqing's first mountain park built by using the slopes under the overpass. It is representative of mountainous underpass green spaces because of its height difference of over 40 m and its large overpass shadow land. Sample 3 is the underpass green space of Yanggongqiao Bridge in Shapingba District (Figure 5, hereinafter referred

to as “Yanggongqiao Green Space”), which is mainly composed of two concave sites that residents must pass through when walking through the inner ring expressway through the footbridge. It is a typical concave underpass green space due to its complex traffic network and numerous entrances and exits. The distribution of its existing sites, facilities and landscape resources is shown in Table 2.

**Table 1.** The general situation of each type of underpass green space.

Object of Study	Terrain Types of Green Space	Major Function	Green Space Area (hm <sup>2</sup> )	Overpass Shadow Area (hm <sup>2</sup> )	Surrounding Environment
Main Wharf Park	Flat green space (The terrain of survey area is flat)	recreation	5.89	0.76	Jialing River is adjacent to its north, and the other three directions are residential quarters and Beibei Sports Park
E'gongyan Park	Mountainous green space (including terrains of side slopes, retaining walls, cliffs and tablelands)	recreation	6.32	2.65	The mountain cliff is in the south, and the difference of elevation in the site is over 40 m. In addition to residential commodities, there are cultural places near it, such as the former site of Chongqing Anti-Japanese War Arsenal and Chongqing Jianchuan Museum
Yanggongqiao Green Space	Concave green space(the terrain height is below the surrounding areas)	recreation and passage	1.43	0.57	It is divided into two by the Inner Ring Expressway, and there are many old communities and schools around it. It is the only public green space within 500 m of walking for 10 min by nearby residents.



**Figure 2.** Location of each underpass green space.



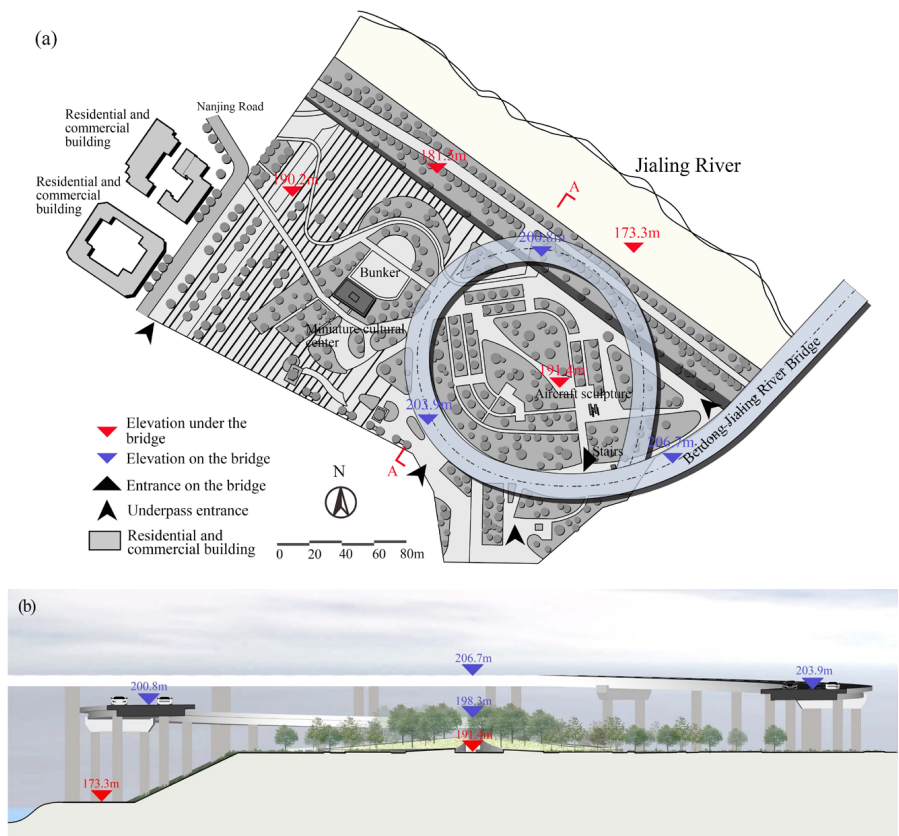


Figure 3. The plan and section of Main Wharf Park: (a) Plan, (b) A-A Section.

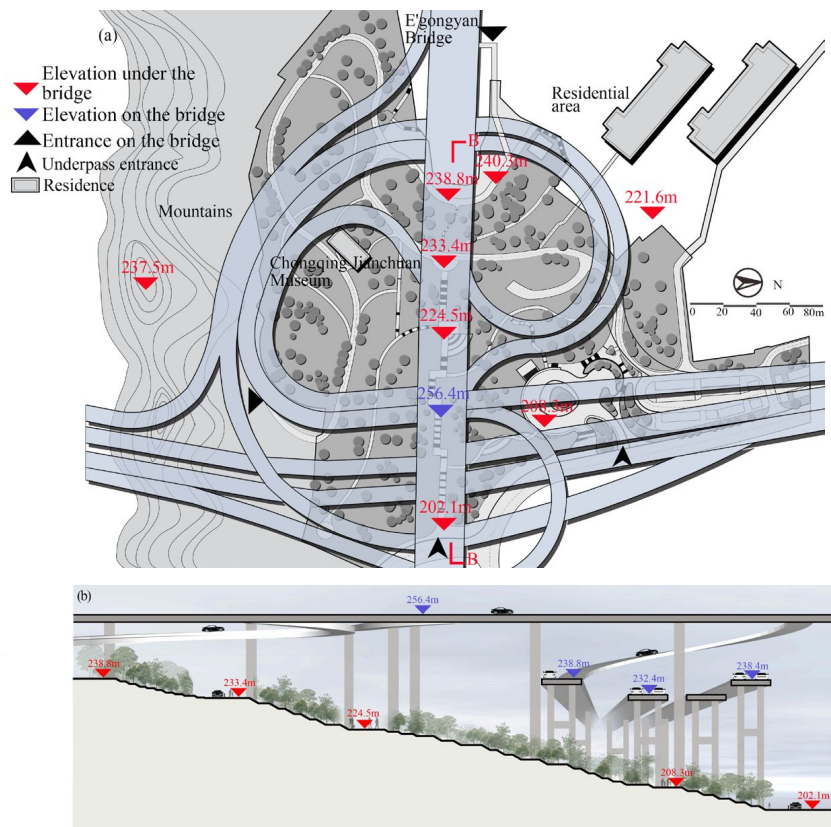
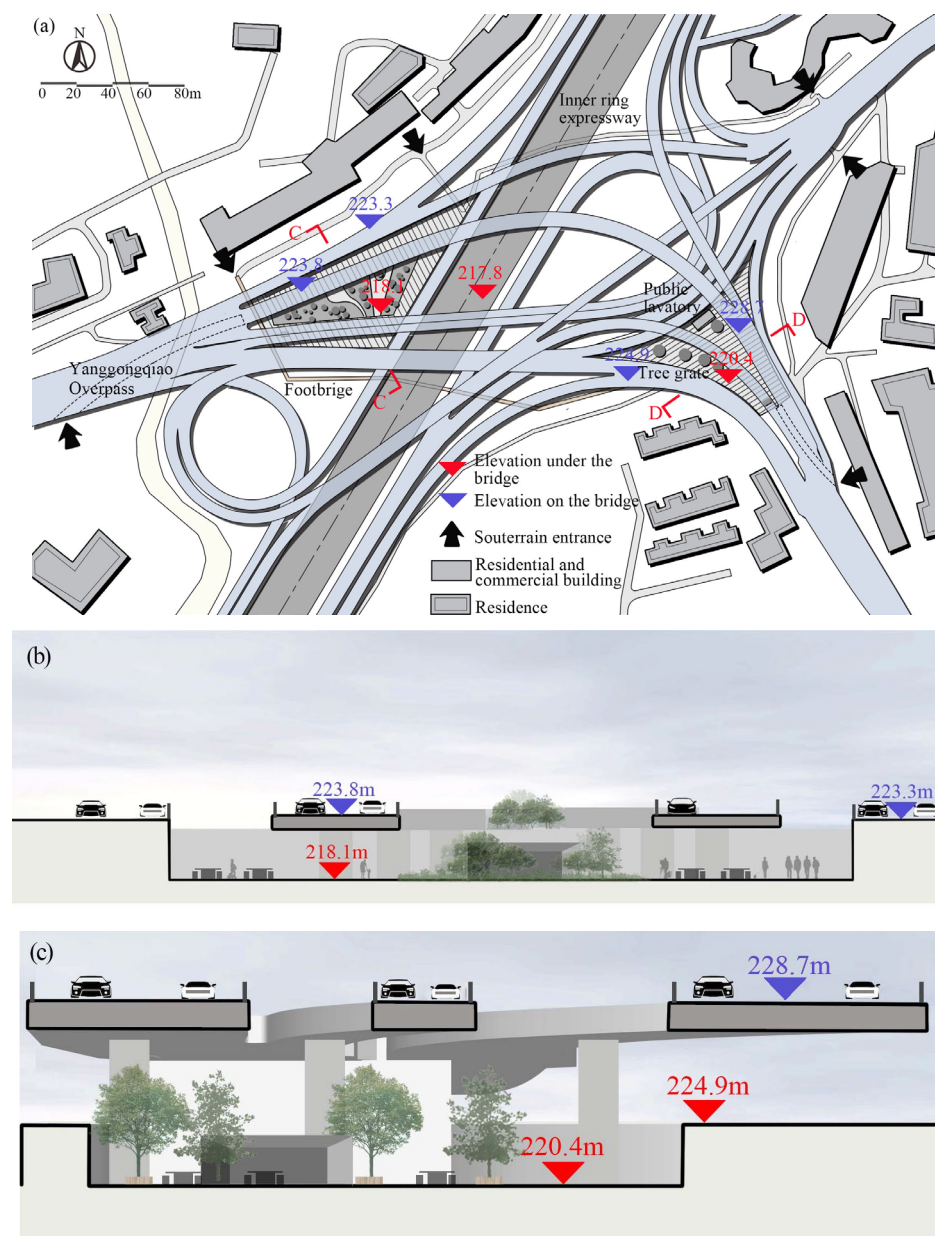


Figure 4. The plan and section of E'gongyan Park: (a) Plan, (b) B-B Section.



**Figure 5.** The plan and section of Yanggongqiao Green Space: (a) Plan, (b) C-C Section, (c) D-D Section.

**Table 2.** Existing sites, facilities and landscape resources of each type of underpass green space.

Item	Category	Main Wharf Park	E'gongyan Park	Yanggongqiao Green Space
Recreation Facilities and sites	Landscape architecture (pavilion, gallery, flower stand)			
	Seating or compound rest facilities	✓	✓	✓
	Chess tables and chairs			✓
	Children's recreation equipment	✓		
	Children's playground	✓		
	Bunker	✓		

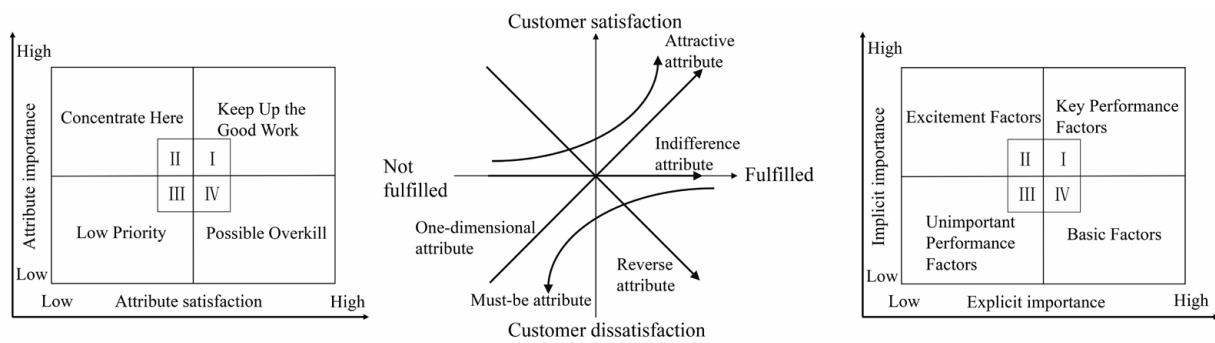
Table 2. Cont.

Item	Category	Main Wharf Park	E'gongyan Park	Yanggongqiao Green Space
Sports facilities and venues	Fitness equipment	✓		✓
	Basketball court			
	Table tennis table	✓		
	Fitness track	✓		
	Pavement activity site under bridge	✓	✓	✓
Sanitation facilities	Public restrooms	✓	✓	✓
	Direct drinking water equipment	✓	✓	✓
Cultural and artistic facilities	Cultural display and scientific and educational facilities	✓	✓	✓
	Public arts facilities	✓	✓	
Other facilities for convenience	Peripheral parking lot	✓	✓	✓
	Barrier-free ramp			
	Tour guide identification system		✓	
	Lighting facilities open at night	✓		✓
	Sales point (small shop or vending machine)	✓		
Landscape resources	Flower border, flower cluster or flower belt	✓	✓	
	Riverside vision	✓		

## 2.2. Methodology

Combined with different quadrants of IPA (Importance-Performance Analysis) and various factor types of Kano model (also known as three-factor theory), the IPA-Kano model betters the understanding of users' views on evaluation factors and contributes to the proposal of reasonable improvement strategies [24,25]. The explicit importance of evaluation factors and the implicit importance, which reflects the influence degree of evaluation factors on overall satisfaction, are analyzed through the IPA-Kano model. The explicit importance and implicit importance are taken as horizontal and vertical axes, respectively. The reference line is established with their average values, and a four-quadrant analysis grid is constructed. The key performance factors (factors of both high explicit importance and high implicit importance) are shown within Quadrant 1; the excitement factors (factors of high implicit importance and low explicit importance) are shown within Quadrant 2; the unimportant performance factors (factors of both low explicit importance and low implicit importance) are shown within Quadrant 3; the basic factors (factors of low implicit importance and high-explicit importance) are shown within Quadrant 4 [26] (Figure 6).

IPA-Kano model has been used in the related fields of science of human settlements. For example, Yin et al. have used this model to discuss the priority factors for improvement among three types of communities in Xi'an, in order to rationally optimize the distribution of resources to improve residents' living satisfaction [27]; based on the concept of perceived value, Chen Luyao et al. have used this model to combine importance of environmental perception with perceived performance to measure greenway recreation satisfaction [13].



**Figure 6.** Related research model of IPA-Kano model.

### 2.3. Screening of Environmental Perception Factors and Questionnaire Composition

Some studies have pointed out that accessibility is an important prerequisite for measuring recreation satisfaction of urban parks [28]. Keunhyun et al. deem that accessibility, an important perception dimension, should be fully considered in the planning of urban parks [29]. Perception quality is a psychological perception activity of visitors' recreational experience on the software and hardware of their destinations. It is a comprehensive evaluation of visitors' satisfaction, which shows how much their own demands are satisfied in landscape, education, services, etc. [30,31]. Based on structural equation model, Mao Xiaogang has concluded that accessibility is the latent variable that has the greatest impact on recreation satisfaction, followed by perception quality [32], and many studies also believe that perception quality has an important influence on visitors' satisfaction [33–35]. Therefore, this paper constructs environmental perception factors from two dimensions: accessibility and perception quality.

With a reference to related papers on recreation environment or experience in comprehensive parks and community parks [32,36–38], a pre-investigation was conducted in the form of interviews in three underpass green spaces, and 88 visitors were randomly asked about their recreational purposes, the environmental factors they paid attention to, their complaints and expectations for the improvement of green space environment, etc. Combined with the characteristics of recreational environment and visitors' recreational activities, the initial evaluation system of visitors' perception of underpass green space was obtained.

Referring to the opinions given by 12 teachers of landscape architecture and other related majors in Chongqing Jiaotong University, the factors with contents included in or interacting with other factors were eliminated, such as daily management and maintenance (included in the factor "Environmental sanitation and relevant facilities" and affects various factors of aesthetic perception), and the distribution of unimpeded facilities (included in "suitability of step or road slope"). Additionally, the factors mentioned less than 22 times by visitors were also excluded, such as the aesthetics of pavement and water, the distance of surrounding sales points, plants and the safety of facilities, the suitability of spatial scale, the air quality and ergonomics, etc. With the guarantee that it reflects the core environmental characteristics of underpass green space, the perception evaluation system was revised and integrated, and finally the tourist perception measurement table was composed of 5 perception dimensions, and 21 environmental perception factors were determined.

The questionnaire consists of two parts: sample composition characteristics and visitors' perception measurement table (Table 3). The latter asks visitors whether a certain environmental perception factor is important and whether their actual performance is satisfactory during visitors' recreation. The Likert 5-level scale assigns scores of 1 to 5, ranging from "very unimportant" to "very important", and "very dissatisfied" to "very satisfied" as the rating criteria for tourists, to obtain tourists' preferences and actual performance towards perceptual factors.



**Table 3.** Visitors' perception measurement table of underpass green space environment in mountainous city.

Dimension Classification	Environmental Perception Dimension	Serial Number	Environmental Perception Factors
Accessibility	Path organization perception	a	Time to reach the green space
		b	Visibility and convenience of entrances and exits
		c	Connectivity of internal spatial point positions
		d	Guides of the identification system
		e	Suitability of step or road slope
Perception quality	Safety and security perception	f	Security of the arrival path
		g	Public security management
		h	Night lighting conditions
		i	Smoothness and slip resistance of pavement
		j	Coordination between green space and the surrounding environment
	Aesthetic perception	k	Ornamental of vegetation
		l	Visual senses of terrain relief
		m	Artistry of public art facilities
	Physical environment perception	n	Effect of noise reduction and sound insulation
		o	Comfort of the microclimate
		p	Environmental sanitation and relevant facilities
		q	Distribution and quantity of leisure facilities
	Activity and cultural perception	r	Adequacy of activity venues
		s	Distribution and quantity of sports facilities
		t	Adequacy of children's playgrounds and equipment
		u	The promotion of culture and history and the education of science

#### 2.4. Data Collection

From July 2021 to April 2022 (including working days and weekends), questionnaires were randomly distributed to visitors in three underpass green spaces, including 120 in Main Wharf Park, 162 in E'gongyan Park and 130 in Yanggongqiao Green Space, totaling 412 (Supplementary Materials). The questionnaires were filled out and collected under the guidance of investigators, and that contributed to a 100% validity rate.

For the convenience of people's understanding, it was necessary to add explanations to some technical terms. For example, the term "security of the arrival path", was described as "Are the walking roads to the green space safe? Are there many surrounding vehicles? Additionally, is there any potential safety hazard?". Another example was the term "connectivity of internal spatial point positions", which was described as "Are the paths between the active areas convenient and perfect?".

### 2.5. Data Analysis

The SPSS software (26.0 version) was used to analyze the reliability and validity of the data. Additionally, the Cronbach's alpha of the total scale is 0.905 (a coefficient of 0.70 or higher is considered high reliability), and the coefficients of all potential variables were higher than 0.7, which suggests that the scale has good internal consistency. Among them, the KMO value is  $0.926 > 0.7$ , and the result of Bartlett's Test of Sphericity shows a significant correlation, which suggests that the structure of perception measurement table is consistent with the theoretical assumption of tabulation, and the analysis is feasible.

## 3. Results

### 3.1. Composition of the Sample Characteristics

It can be seen from the basic information of the sample (Table 4) that the respondents in Main Wharf Park and E'gongyan Park are mainly working staffs, many respondents in Main Wharf Park are doing physical exercises, visitors on their first visits predominate in E'gongyan Park, while the majority of the respondents in Yanggongqiao Green Space are retirees, and most of them pay a visit on a daily basis, mainly for passing by and doing physical exercises purposes. Most of the respondents in the three underpass green spaces have incomes between RMB 3000 and RMB 5000. The average income of respondents in the main wharf park is the highest, while the average income of respondents in the Yanggongqiao Green Space is the lowest. Respondents in the three green spaces all mainly arrive on foot.

**Table 4.** Basic information statistics of the samples (See Appendix A for the classification of recreational activities).

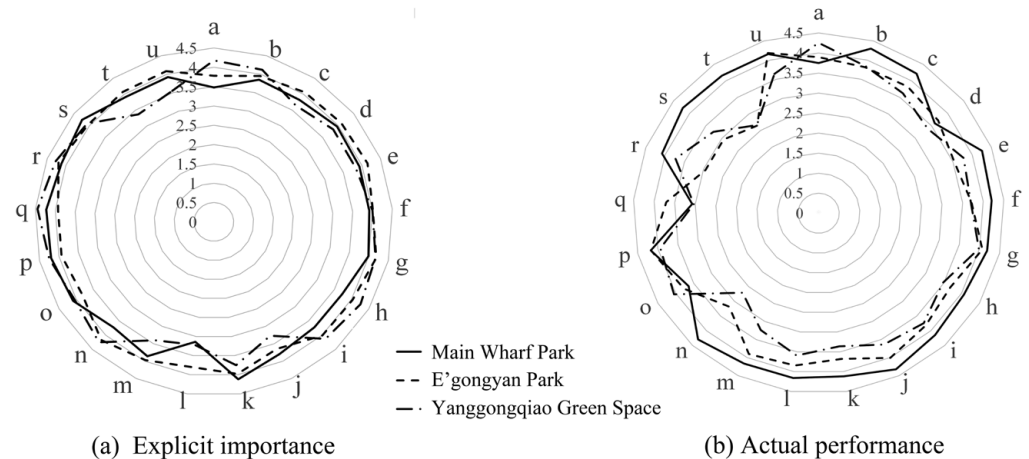
Item	Category	Percent/%		
		Main Wharf Park	E'gongyan Park	Yanggongqiao Green Space
Gender	Male	49.17	54.32	56.92
	Female	50.83	45.68	43.08
Age	<age 18	16.67	9.88	3.08
	Age 19–35	27.50	31.48	34.62
	Age 36–59	30.00	30.25	27.69
	>age 60	25.83	28.40	34.62
Occupation	Students	20.83	16.05	15.38
	Working staffs	35.83	38.27	27.69
	Retirees	27.50	27.78	36.92
	Unemployed at present	15.83	11.11	14.62
	Others	0.00	6.79	5.38
Income	Below 3000 CNY	15.83	21.60	28.46
	3000–5000 CNY	38.33	36.42	34.62
	5000–7000 CNY	25.83	20.99	20.00
	7000–10,000 CNY	14.17	17.90	13.85
	Above 10,000 CNY	5.83	3.09	3.08
Recreation frequency	Once a day	20.00	18.52	46.15
	Above twice a week	30.00	17.28	20.00
	Once or twice a week	20.00	14.81	12.31
	Once or twice a month	21.67	20.37	6.92
	First visit	8.33	29.01	14.62

Table 4. Cont.

Item	Category	Percent/%		
		Main Wharf Park	E'gongyan Park	Yanggongqiao Green Space
Recreation purpose	Getting close to nature	10.83	20.37	2.31
	Doing physical exercises	25.00	17.90	23.84
	Getting rest	24.17	29.01	13.08
	Recreational hobbies	14.17	5.56	22.31
	Emotional communication	22.50	18.51	13.08
	Passing by	3.33	8.64	25.38
Mode of transportation	Walking	48.33	58.64	86.92
	Bicycle	5.00	0.00	0.00
	Motor vehicle	11.67	22.22	0.77
	Rail transit	18.33	16.67	10.77
	Bus	16.67	2.47	1.54

### 3.2. Explicit Importance and Actual Performance of Environmental Perception Factors

Explicit importance shows visitors' direct evaluation of the importance of environmental perception factors. Figure 7a shows among all of the three underpass green spaces, visitors have a strong preference for the perception factors, such as the security of the arrival path, public security management, environmental sanitation and relevant facilities, distribution and quantity of leisure facilities, the adequacy of activity venues and distribution and quantity of sports facilities; the least important factor of Main Wharf Park and Yanggongqiao Green Space lies in visual senses of terrain relief, while that of E'gongyan Park rests with the coordination between green space and the surrounding environment.



**Figure 7.** Explicit importance and actual performance of environmental factors of each underpass green space (see Table 3 for the serial numbers of corresponding perception factors).

In terms of the actual performance of environmental perception factors (Figure 7b), the scores of public security management, environmental sanitation and relevant facilities are high in all of the three underpass green spaces researched; the actual performance score is relatively high in most perception factors of Main Wharf Park, and the distribution and quantity of leisure facilities scores the lowest. E'gongyan Park has the highest performance score in the promotion of culture and history and the education of science, but low scores in the effect of noise reduction and sound insulation, adequacy of activity venues, distribution

and quantity of sports facilities, and adequacy of children's playgrounds and equipment are all low. Yanggongqiao Green Space has the best performance in the time to reach the green space, but has poor performance in the effect of noise reduction and sound insulation, distribution and quantity of leisure facilities, and adequacy of children's playgrounds and equipment.

### 3.3. Implicit Importance of Environmental Perception Factors

The value of implicit importance is obtained from the bivariate correlation analysis coefficient between the actual performance of perception factors and the overall satisfaction of perception factors [39], which can more accurately reflect the influence degree of environmental perception factors on the overall satisfaction. When the correlation coefficient between the performance value of environmental perception factors and overall satisfaction of perception factors is high, the implicit importance is relatively high, and vice versa [13]. It can be seen from Table 5 that there are significant differences in the implicit importance ranking of each perception factor of the three underpass green spaces, for example, the distribution and quantity of sports facilities and the effect of noise reduction and sound insulation have higher implicit importance in E'gongyan Park and Yanggongqiao Green Space, and those of Main Wharf Park are centered. Ornamental of vegetation ranks first in the implicit importance of Yanggongqiao Green Space, but ranks lower in that of Main Wharf Park and E'gongyan Park.

**Table 5.** Implicit importance of environmental perception factors of three underpass green spaces.

Environmental Perception Factors	Main Wharf Park		E'gongyan Park		Yanggongqiao Green Space	
	Score	Ranking	Score	Ranking	Score	Ranking
Time to reach the green space	0.072	21	0.189	20	0.110	21
Visibility and convenience of entrances and exits	0.785	3	0.319	13	0.314	18
Connectivity of internal spatial point positions	0.751	9	0.467	10	0.532	6
Guides of the identification system	0.384	18	0.434	12	0.473	12
Suitability of step or road slope	0.760	6	0.287	14	0.424	14
Security of the arrival path	0.755	7	0.469	9	0.493	9
Public security management	0.714	17	0.247	17	0.145	20
Night lighting conditions	0.824	1	0.566	5	0.475	11
Smoothness and slip resistance of pavement	0.780	4	0.441	11	0.484	10
Coordination between green space and the surrounding environment	0.747	10	0.255	15	0.526	7
Ornamental of vegetation	0.720	15	0.190	19	0.591	1
Visual senses of terrain relief	0.795	2	0.136	21	0.573	2
Artistry of public art facilities	0.752	8	0.205	18	0.463	13
Effect of noise reduction and sound insulation	0.728	12	0.605	2	0.534	5
Comfort of the microclimate	0.247	19	0.568	4	0.342	17
Environmental sanitation and relevant facilities	0.724	13	0.519	7	0.375	16
Distribution and quantity of leisure facilities	0.082	20	0.583	3	0.390	15



Table 5. Cont.

Environmental Perception Factors	Main Wharf Park		E'gongyan Park		Yanggongqiao Green Space	
	Score	Ranking	Score	Ranking	Score	Ranking
Adequacy of activity venues	0.770	5	0.252	16	0.514	8
Distribution and quantity of sports facilities	0.720	14	0.644	1	0.537	4
Adequacy of children's playgrounds and equipment	0.715	16	0.529	6	0.557	3
The promotion of culture and history and the education of science	0.734	11	0.507	8	0.270	19

### 3.4. Three-Factor Analysis of Environmental Perception Factors

According to the explicit and implicit importance, an analysis grid map on IPA-Kano model was constructed (Figure 8), and based on the similarity and difference of visitors' perception of the environment of three underpass green spaces, a three-factor analysis diagram including basic factors, key performance factors and excitement factors is classified (Figure 9).

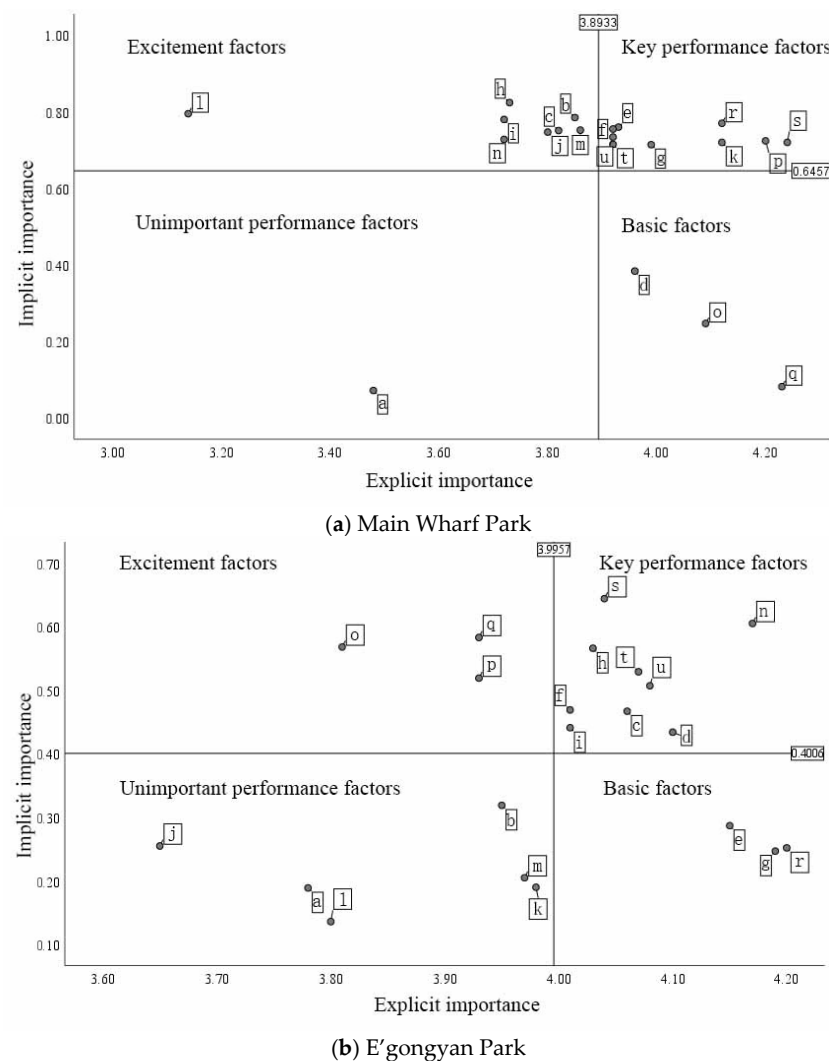
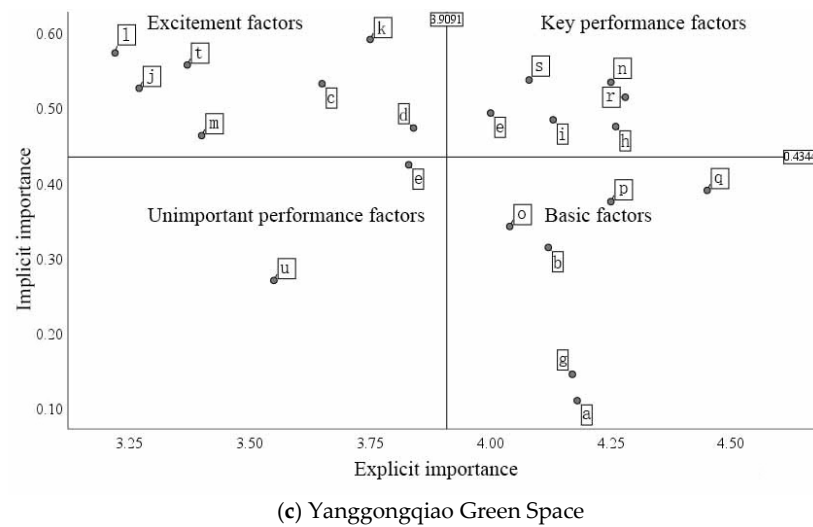
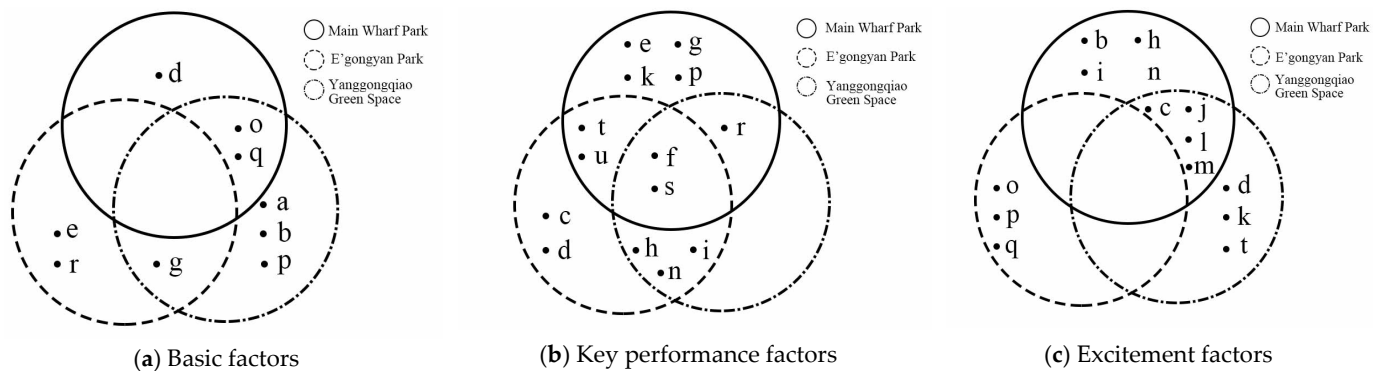


Figure 8. Cont.



**Figure 8.** Grid map of environmental perception factors of three underpass green spaces (see Table 3 for the serial numbers of corresponding perception factors).



**Figure 9.** Three-factor analysis diagram of three underpass green spaces (see Table 3 for the serial numbers of corresponding perception factors).

(1) Visitors consider that the basic factors are of great importance, but their changes have little impact on the overall satisfaction evaluation, that is, the basic factors are the most basic functions of green space and should be provided “naturally” [40]. It can be seen from Figure 9a that among the basic factors, visitors deem that improving the microclimate comfort of the underpass green space and optimizing the distribution and quantity of leisure facilities is conducive to enhance the recreation experience of Main Wharf Park and Yanggongqiao Green Space; they believe that enhancing the public security management can benefit the service quality of E’gongyan Park and Yanggongqiao Green Space. (2) The improvement of the performance value of key performance factors is beneficial to the promotion of the overall satisfaction evaluation of underpass green space, so it is also very important. In this type, the security of the arrival path, distribution and quantity of sports facilities are the common factors of the three underpass green spaces. There are one to three common factors between any two of the three underpass green spaces. (3) While visitors think that the importance of excitement factors is relatively low, the decrease in the performance value of such factors can also lead to a decline in overall satisfaction. Among the excitement factors, the connectivity of internal spatial point positions and three environmental perception factors of physical environment perception are the common factors of Main Wharf Park and Yanggongqiao Green Space.

### 3.5. The Ranking of Environmental Factors Needing to Be Optimized

Using three-factor analysis alone to provide suggestions for the improvement of the attraction of the underpass green space is not sufficient enough. The actual performance of perception factors is divided into three categories according to the ranking order: A (1–7), B (8–14) and C (15–21). Combined with three-factor analysis, the environmental factors that affect the optimization of the service quality of underpass green space can be divided into four levels according to the priority order [27]. Additionally, the environmental factors that need to be optimized in different underpass green spaces are sorted as shown in Table 6, and the quantitative order is shown as E'gongyan Park (quantity: ten) of mountainous green space > Main Wharf Park (quantity: nine) of flat green space > Yanggongqiao Green Space (quantity: six) of concave green space. Among them, the distribution and quantity of leisure facilities, the effect of noise reduction and sound insulation, adequacy of activity venues and the distribution and quantity of sports facilities are the environmental factors with Priority Level I and II in the two green spaces.

**Table 6.** Rankings of the environmental factors needing to be optimized in different underpass green spaces.

Priority Order	Dividing Standard	Environmental Perception Factors	Main Wharf Park	E'gongyan Park	Yanggongqiao Green Space
I	Basic factors + Performance Level C	Guides of the identification system	✓		
		Suitability of step or road slope		✓	
		Comfort of the microclimate	✓		
		Distribution and quantity of leisure facilities	✓		✓
		Adequacy of activity venues		✓	
II	Key performance factors + Performance Level C	Night lightning conditions		✓	
		Ornamental of vegetation	✓		
		Effect of noise reduction and sound insulation		✓	✓
		Adequacy of activity venues	✓		
		Distribution and quantity of sports facilities		✓	✓
		Adequacy of children's playgrounds and equipment		✓	
III	Basic factors + Performance Level B	Deficiency			
IV	Key performance factors + Performance Level B	Connectivity of internal spatial point positions		✓	
		Guides of the identification system		✓	
		Security of the arrival path		✓	✓
		Public security management	✓		
		Night lightning conditions			✓
		Smoothness and slip resistance of pavement		✓	
		Environmental sanitation and relevant facilities	✓		
		Adequacy of children's playgrounds and equipment	✓		
		Adequacy of activity venues			✓
		The promotion of culture and history and the education of science	✓		

For the environmental perception dimension of path organization, guides of the identification system in Main Wharf Park rank as Priority Level I. Despite a relatively flat green space in the park, the deficiency of the tour guide identification system is not

conducive to visitors who are unfamiliar with the park to organize tour routes. The suitability of step or road slope in E'gongyan Park ranks as Priority Level I, and the connectivity of internal spatial point positions and the guides of the identification system ranks as Priority Level IV; this green space was constructed relying on mountains, too many steps and the lack of barrier-free ramps, making it inconvenient for people with mobility difficulties and baby carriages. The paths between the landscape nodes in mountainous green space are connected in a more circuitous and complicated way than those of flat ground types; visitors who are unfamiliar with the green space often need guide maps and signs to assist them to reach each point position.

For the environmental perception dimension of safety and security, the night lighting conditions rank as Priority Level II and Level IV, respectively, in E'gongyan Park and Yanggongqiao Green Space. The park lighting of these two green spaces is either off or dim at night, and visitors need to rely on the faint lights projected by street lamps on the bridge during their visits, which may lead to great safety hazards. Secondly, the security of the arrival path ranks as Priority Level IV in E'gongyan Park and Yanggongqiao Green Space. There exists traffic security hazards on the arrival paths in these two green spaces due to the heavy traffic around them. The smoothness and slip resistance of pavement ranks Priority IV in E'gongyan Park, which shows that the safety of visitors needs to be guaranteed in the choice of pavement materials, especially in the underpass green space with a large vertical drop. For aesthetic perception, the ornamental of vegetation is rated Priority Level II in Main Wharf Park; the vegetation landscape in the green space of flat ground type has no terrain as its skeleton support, which results in a lack of layer effects. Thus, the vegetation there is easy to appear monotonous and dull, and lacks visual impact.

For the physical environment perception, the comfort of the microclimate ranks as Priority Level I in Main Wharf Park; that is because the overpass shadow land accounts for a relatively low proportion of green space in the park, and most sites and roads there are not shaded by trees or landscape architecture, which makes visitors' experience easily affected by wind, sun and rain. The effect of noise reduction and sound insulation is rated as Priority Level II both in E'gongyan Park and Yanggongqiao Green Space on account of the large noise caused by the large traffic volume on and around the overpasses. Although the priority of environmental sanitation and relevant facilities in Main Wharf Park ranks as not high, visitors' experience is also affected due to the open defecation of pets and a lack of sanitation facilities, such as trash cans, hand basins and public drinking water equipment.

For activity and cultural perception, the distribution and quantity of leisure facilities rank as Priority I in Main Wharf Park and Yanggongqiao Green Space, which indicates that their leisure facilities are of great deficiency. On account of this, visitors even need to carry seats to play chess and cards, or chat and have other activities in Yanggongqiao Green Space. The adequacy of activity venues has different priorities in the three underpass green spaces; it ranks as Priority I and II, respectively, in E'gongyan Park and Main Wharf Park. Limited by the mountainous terrain, only one activity venue is set up in the former green space, which is far from meeting the activity needs of surrounding residents. While there is a large square in the latter, the flow of people heading to the riverside interferes greatly with the crowd activities in the square; thus, it is necessary to open up an independent activity venue for visitors to move. Activity venues account for a large proportion of Yanggongqiao Green Space, so this factor ranks relatively low in the priority level. However, due to the high-population density and lack of public green space around it, citizens still expect more activity venues to be set. The distribution and quantity of sports facilities rank Priority Level II both in E'gongyan Park and Yanggongqiao Green Space. The former does not set up sports facilities on the limited flat ground, while the latter only sets up a small amount of fitness equipment beside public toilets, leading to the demand for sports facilities exceeding its supply. The adequacy of children's playgrounds and equipment in E'gongyan Park and Main Wharf Park is at Priority Level II and IV, respectively. The playgrounds and equipment for children's activities are completely missing in the former green space; the latter has set up amusement facilities such as bunkers and seesaws, however, there are few types and the



items are not diverse enough. For Yanggongqiao Green Space, however, because of serious automobile exhaust pollution and frequent pedestrian flow, its environment is not suitable for children to play, so this factor has not entered priority ranking.

Therefore, there are multiple reasons affecting the priority ranking of the environmental perception factors of the underpass green spaces that need to be optimized: the insufficiency of safety guarantee or the lack of facilities of the underpass green spaces, such as existing activity venues, identification systems, park lighting, pavements, garbage bins, landscape architecture, leisure and sports facilities, amusement equipment; the particularity of the underpass environment, such as the landscape resources, i.e., ornamental plants, the surrounding traffic safety, noise or air pollution; and different terrain types.

#### 4. Discussion

The study found that for the explicit importance of environmental perception factors of underpass green space among the five dimensions, the scores of physical environment perception, activity and cultural perception of three underpass green spaces are relatively high, while the scores of aesthetic perception are relatively low, which shows that visitors attach great importance to the physical environment quality of underpass green spaces, focusing on physical and psychological activity experience, but have relatively low demands for visual senses of underpass green spaces.

In terms of the actual performance of the five dimensions, the dimension to which visitors attach general importance, activity and cultural perception scored the lowest in the three underpass green spaces. The reasons are as follows: the unfavorable factor of Main Wharf Park lies in the lack of leisure facilities; in addition to the lack of leisure facilities, Yanggongqiao Green Space also lacks sports facilities; E'gongyan Park not only lacks playgrounds and sports facilities but also lacks venues and equipment for children to have fun and play. Leisure facilities have an important impact on visitors' recreation experience. With reference to the boundary effect, compound leisure facilities can be set up flexibly in combination with piers, low walls, tree grates, or sculptures, so as to promote citizens' residence and social interaction activities. Studies have shown that there is a positive correlation between the area of flat ground and the number of people having activities in the green space [41]. Fitness activities, such as dance, Tai Chi, exercise with fitness facilities and recreational hobbies, e.g., chess, cards and musical instrument playing, mostly demand a flat ground. Therefore, adding activity venues can increase the frequency and duration of visitors' activities [42]. It is common for middle-aged and elderly people to take their children and grandchildren with them for recreation in the underpass green spaces. To care for children's growth, these green spaces need to be equipped with bunkers and other playgrounds and equipment that are suitable for children, and meet their psychological needs, which can promote parent-child activities and intergenerational exchanges. Shaded from the sun and rain, the overpass shadow land often has a more comfortable microclimate than other areas. Since the overpass shadow land accounts for a relatively small proportion of Main Wharf Park and the site lacks shade facilities, the actual performance value of the comfort of microclimate is relatively low. For this reason, the arbor with a high-coverage rate can be planted beside the activity venue or along the park roads, and landscape architecture such as pavilions, corridors or flower stands can also be added to meet the somatosensory needs of visitors in different seasons and time periods. Though Yanggongqiao Green Space has a monotonous plant landscape and a relatively low ornamental value, it can use ornamental and seasonally varied plants to highlight the landscape's visual attraction based on the principle of diversity and variability in plant configuration [43]. This can enhance the ornamental value of the green space and enrich its spatial layer effects. Meanwhile, the restorative environment created by plants can also relieve the mental stress of tourists [44], promote them to take part in recreational activities close to nature, such as enjoying the scenery and taking pictures, and enrich the service function of underpass green spaces.

In addition to the existing sites, facilities and landscape resources, the particularity of the underpass environment and the terrain types are also important reasons that lead to the different test results of the three underpass green spaces. Based on the three factors of environmental perception factors and the results of the priority ranking of factors needing to be optimized, in order to improve the service quality and recreation satisfaction of underpass green spaces, the optimization suggestions of the service function of underpass green spaces are put forward, aiming at three terrain types of mountainous cities, from five perception dimensions (Figure 10). The first is the path organization, in terms of external accessibility, underpass green spaces mainly serve the residents of nearby communities. Regarding the visibility and convenience of entrances and exits, the three underpass green spaces are all surrounded by a dense road network and have a variety of surrounding land types. Main Wharf Park has a flat topography and the main pedestrian entrances and exits are located under the bridge, making it the best in terms of external accessibility; Yanggongqiao Green Space has a certain height difference from the surrounding roads, but it has more pedestrian entrances and exits in the underground passages, making it the second most accessible; The two main pedestrian entrances and exits of E'gongyan Park, which are only 1.5 m wide, are located on the overpass, and visitors have to walk down about 16 m of steps to reach this green space. Visibility and convenience are weak, and external accessibility is the worst, but people living under the bridge and visitors arriving from riverside roads can enter the green space more easily through the entrance under the bridge. The time to reach the green space is the basic factor of Yanggongqiao Green Space. The nearby communities of Yanggongqiao Green Space lack activity venues but there are a large number of middle-aged and elderly people living there. Consequently, the surrounding "capillary" traffic network should be diverted to ensure the smoothness and continuousness of slow traffic, and shorten the arrival time of residents as much as possible. The underpass green spaces in mountainous cities are more richly layered because their sites and spaces are separated by various types of terrain, overpass surface and underpass spatial structure, such as piers. In terms of internal accessibility, while flat underpass green space has flat terrain and wide sight, it is still necessary to add positioning and guiding signs to guide citizens who are unfamiliar with the tour path, and increase the frequency use of different functional venues; on account of the complex terrain and low direction recognition, the recognition and convenience of entrances and exits in addition to clear tour guide signs should be paid special attention to among the mountainous green spaces and concave green space. However, the mountainous underpass green space has large vertical height differences. So, on the premise of satisfying ergonomics, multiple measures could be taken, such as reasonable layout of steps, circuitous slowing of slopes along terrain, and addition of barrier-free ramps to make the tour route more convenient. In the meantime, hurdles should be removed for the elderly and children to increase the internal accessibility of underpass green space for all age groups.

A good security guarantee is a prerequisite for increasing the frequency of green space access and prolonging recreation time [45]. In the dimension of safety and security perception, the security of the arrival path is the key performance factor shared by all the three types of underpass green spaces. The traffic environment around the underpass green space is more complex than that of ordinary green space. In addition to ensuring the connection between sidewalks, park entrances and exits, crossing facilities such as zebra crossings, traffic lights, footbridges or underground passages can be established to improve the safety and convenience of pedestrian crossings, and improve its level of being slow pedestrian-oriented as a whole. Regarding the mountainous underpass green space and concave underpass green space, visitors are often prone to have blind spots there resulting from the underpass environment, which is affected by lighting, terrain and piers; therefore, public security patrol and safety monitoring need to be put in place sufficiently in these green spaces. In addition, for the safety of passage and recreation, the layout of park lighting cannot be ignored, which can enrich residents' night fitness, entertainment and social activities, and also improve the utilization rate of green space at night; compared

with flat ground, more attention should be paid to the flatness and anti-skid performance of the materials used for pavements.

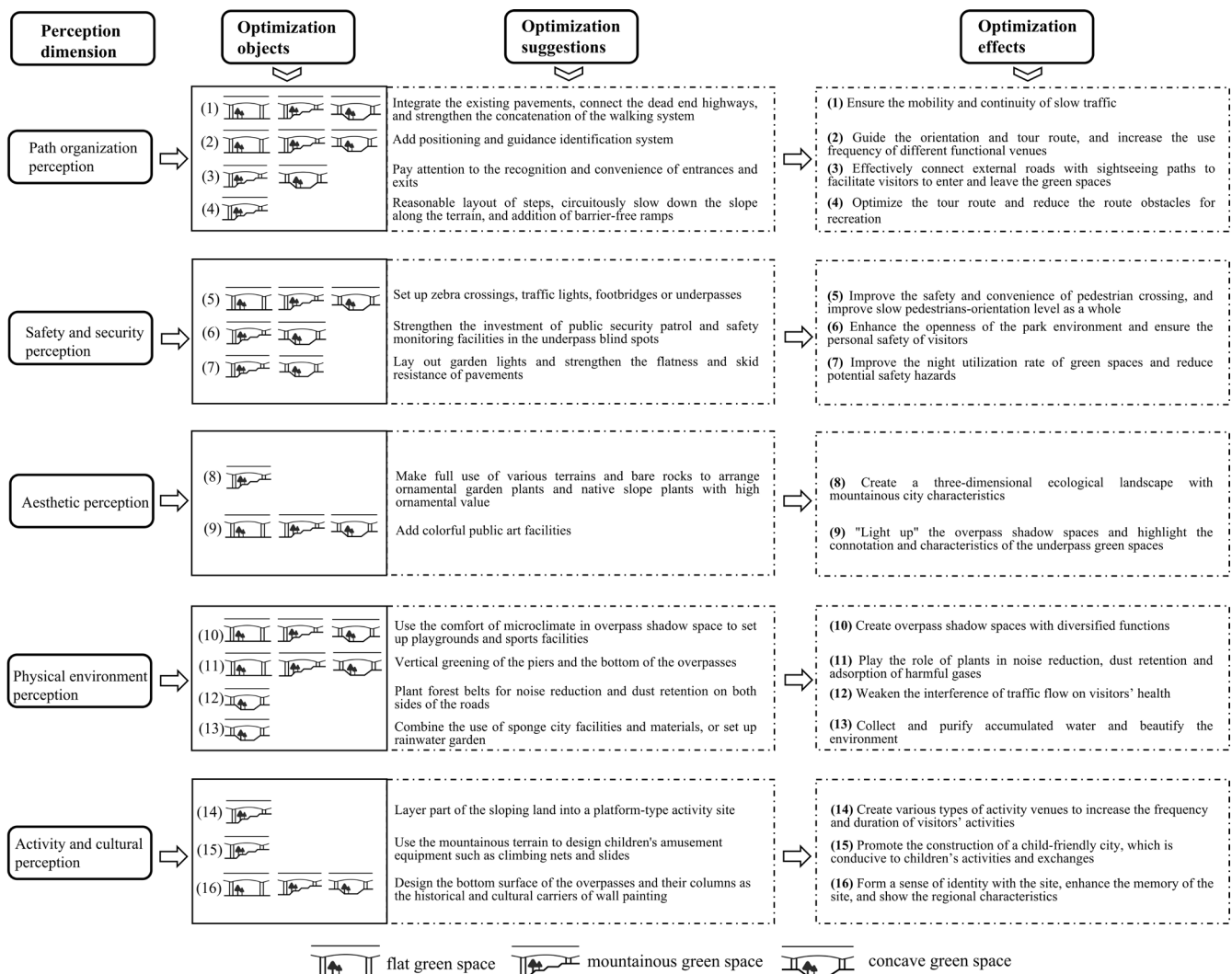


Figure 10. Optimization suggestions for three types of underpass green space.

Considering the aesthetic-perception dimension, the mountainous underpass green space can build a three-dimensional ecological landscape with characteristics of mountainous cities that integrates into the surrounding environment via fully utilizing diverse terrain and bare rocks, high-ornamental garden plants and native slope plants. Despite the fact that the artistry of public art facilities is rated as a excitement factor in only two underpass green spaces, when considering the poor lighting of the overpass shadow land, the colorful public art facilities can "light up" the space, which can also be used as the visual focus of the flat green space without many terrain changes. They can bear the historical culture and regional characteristics while highlighting the connotation and peculiarity of the underpass green spaces. Comfortable microenvironment quality can improve the utilization rate of public space [46]. For the dimension of physical environment perception, activity venues, table tennis tables, fitness equipment and other sports facilities can be set up in the overpass shadow land according to the needs of visitors, and the comfort of its microclimate can be utilized to create an overpass shadow land with diversified functions. Due to the functions of plants in noise reduction [47], dust retention [48] and harmful gas adsorption [49], the pier and the bottom of the overpass can be vertically afforested, which can alleviate the noise and automobile exhaust pollution on the roads and overpasses to a certain extent. For the concave underpass green space, due to the proximity to the main traffic route, this

would lead to a higher exposure to toxic and harmful substances coming from vehicular exhausts, as well as the walls of retaining wall, which would weaken the diffusion of wind on toxic and harmful substances, leading to an increase in the concentration of toxic and harmful substances [50,51]. In this regard, forest belts with the function of noise reduction and dust retention can be planted on both sides of the road to minimize the interference of traffic flow on the health of visitors. To solve the problem that dirty water can easily accumulate in this place, resulting from its concave terrain, the sponge city facilities and materials can be utilized, or a rainwater garden can be set up to collect and purify the accumulated water while beautifying the environment.

In regard to the dimension of activity and cultural perception, the distribution and quantity of sports facilities are the common key performance factors shared by the three types of underpass green space. In the post-COVID era, people's health awareness is enhanced. Diversified activity venues should be created in the underpass green spaces in mountainous cities—a scarce public space, according to the needs of visitors on the premise of ensuring the greening rate—so as to facilitate people's various activities. Since the excavation of the sites in mountainous underpass green spaces is limited by the terrain, some slopes can be layered into platform-type activity sites. In order to promote the construction of a child-friendly city, children's amusement equipment such as climbing nets and slides can also be designed on the basis of the mountain terrain. Lastly, the site environment with the cultural atmosphere is conducive to forming a sense of identity with the site [52], enhancing people's memory of the place, reflecting its regional characteristics and improving the recognizability of the place. For example, E'gonggyan Park has a strong cultural atmosphere in its surrounding places. It promotes a local culture in public art installations, guide boards and posters, which results in a high evaluation of its performance of the promotion of culture and history and the education of science. In addition, the bottom surface of the overpasses and piers can be used as historical and cultural carriers of wall painting to meet the deep needs of visitors for open space.

## 5. Conclusions

To optimize the deployment and usage of underpass green spaces and improve the comprehensive environmental quality and livability of the city, this study is carried out in Chongqing, a typical mountainous city in China, concerning the visitors' demands and feelings, producing a quantitative study on the relationship between environmental factors of underpass green spaces and visitors' recreation experience from the perspective of environmental perception, and summarizing the environmental factors that can improve the service quality of underpass green spaces with different types of terrain and enhance visitors' recreation experience. The results show that: (1) During the process of recreation in the underpass green spaces, visitors attach more importance to the quality of the physical environment, psychological and physical activity experience, and less importance to the visual senses; due to the inadequacy or absence of leisure facilities, sports facilities, children's playgrounds and amusement equipment in the three underpass green spaces, visitors' evaluation of activity and cultural perception is the lowest among the five dimensions. (2) The existing sites, facilities and landscape resources, as well as the specificity of the underpass environment and the different terrain types, largely influence the performance and priority ranking of environmental perception factors. (3) Improvements in either the security of the arrival paths or the sports facilities are conducive to improving visitor satisfaction in the three types of underpass green spaces; the mountainous underpass green spaces require the most environmental factors to be optimized, followed by the flat and concave types. The results of this study will help to improve the environmental and service functions of underpass green spaces in hilly or mountainous cities with high-density interchange networks (e.g., Chongqing, Guiyang and Shiyang in China, as well as Seoul in South Korea and Rio de Janeiro in Brazil).

Our study has some limitations regarding the selection of environmental perception factors. Visitors' perception of ecological factors are perhaps indirect, resulting in a lack



of questions directly related to ecology in the questionnaire. Underpass green spaces are similar to community parks or roadside green spaces in terms of recreational and ecological functions, creating a natural and wild-living environment for residents, while performing functions, such as carbon sinks [53], storm-water absorption [54], habitat creation and increasing biodiversity [55]. Therefore, future studies may seek to use scientific methods to evaluate the ecological value of underpass green spaces. On the other hand, accessibility to green spaces is one of the most widely used spatial-exposure metrics in green justice research [56,57]. The underpass green space can alleviate the inequity of urban green space supply and meet the needs of different social groups for green exposure [58]. In the future, with the completion and use of more underpass green spaces, their accessibility will be more concerned. In this paper, the accessibility is only assessed by the perception of visitors, but not measured and analyzed; later on, the accessibility can be analyzed by 3S technology and urban big data. The distribution of underpass green spaces in mountainous or hilly cities with high-density interchange networks can be explored in depth, which can help promote the construction of “15 min cities”.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/buildings13061489/s1>. Mountainous City Underpass Green Space Survey Questionnaire.

**Author Contributions:** Conceptualization, J.Z. and J.L.; methodology, J.Z.; software, J.L.; validation, J.Z. and F.L.; formal analysis, J.Z. and J.L.; investigation, J.Z., J.L., Q.H. and L.W.; resources, J.Z.; data curation, H.Y. and J.Q.; writing—original draft preparation, J.L.; writing—review and editing, J.Z. and Q.H.; visualization, J.Z. and J.L.; supervision, J.Z.; funding acquisition, H.Y. and J.Q. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by (1) Social Science Planning Project of Chongqing (Grant No. 2020QNYS78). (2) Urban Management Research Project of Chongqing (Grant No. 10 of 2022). (3) Science and Technology Research Program of Chongqing Municipal Education Commission (Grant No. KJQN202000713).

**Data Availability Statement:** The data used to support the findings of this study are available from the corresponding author upon request.

**Acknowledgments:** Thanks to Yurui Song, Qin Zeng, Qiuhan Chen, Yongyan Zhu Fengtao Yu and Zhenxing Wang, Meng Yi, students of the School of Architecture and Urban Planning of Chongqing Jiaotong University, as well as Qiaoqiao Liu, Yue Zeng and Kangxu Yuan, students of Chongqing Qiu-jing Middle School, for their help in data collection; Thank Luyao Chen and Jize Shen, students of the School of Architecture and Urban Planning of Chongqing University, for their help in data processing.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

The classification of recreational activities: Getting close to nature includes viewing flowers, sightseeing, photography, flying a kite, walking dogs, camping, etc. Getting rest includes sitting, lying, reading, meditation, looking, basking in the sun, etc. Recreational hobbies include singing, musical instrument playing, chess, onlooking, drinking tea, popularization of science, etc. Emotional communication includes chatting, partying, parent-child activity, taking photos, play, etc. Doing physical exercises includes running, walking, aerobics, Qigong boxing, Tai Chi, square dancing, exercise with fitness facilities, dragon dancing, kicking a shuttlecock and other sports.

## References

1. Zhang, J.J.; Zeng, Q.; Luo, R.R. Evaluation and optimization strategy of spacial landscapes under viaducts in Chongqing. *Highway* **2022**, *67*, 392–398.
2. Yin, L.H.; Hang, T.; Qin, F.F.; Lin, X.T.; Han, Y.W. Measuring and quantifying impacts of environmental parameters on airborne particulate matter in under-viaducts spaces in Wuhan, China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5197. [[CrossRef](#)]
3. Zhang, Y.F.; Li, J.; Chen, Z.W.; Xu, X.Y. Dynamic analysis of metro vehicle traveling on a high-per viaduct under crosswind in Chongqing. *Wind Struct.* **2019**, *29*, 299–312.

4. Gronroos, C. A service quality model and its marketing implications. *Eur. J. Mark.* **1984**, *18*, 36–44. [\[CrossRef\]](#)
5. Pizam, A.; Neumann, Y.; Reichel, A. Dimensions of tourist satisfaction with a destination area. *Ann. Tour. Res.* **1978**, *5*, 314–322. [\[CrossRef\]](#)
6. Sant’Anna, D.O.; Dos Santos, P.H.; Vianna, N.S.; Romero, M.A. Indoor environmental quality perception and users’ satisfaction of conventional and green buildings in Brazil. *Sustain. Cities Soc.* **2018**, *43*, 95–110. [\[CrossRef\]](#)
7. Liu, B.Y.; Du, H.Y.; Fan, J.; Huang, B.R.; Zhou, K.; Gong, J. The gap between public perceptions and monitoring indicators of environmental quality in Beijing. *J. Environ. Manag.* **2021**, *277*, 111414. [\[CrossRef\]](#)
8. Ittelson, W.H. Environmental perception and urban experience. *Environ. Behav.* **1978**, *10*, 193–213. [\[CrossRef\]](#)
9. Shi, X.M.; Song, Z. The silent majority: Local residents’ environmental behavior and its influencing factors in coal mine area. *J. Clean. Prod.* **2019**, *240*, 118275. [\[CrossRef\]](#)
10. Liu, J.C.; Sheldon, P.J.; Var, T. Resident perception of the environmental impacts of tourism. *Ann. Tour. Res.* **1987**, *14*, 17–37. [\[CrossRef\]](#)
11. Ragavan, N.A.; Subramonian, H.; Sharif, S.P. Tourists’ perceptions of destination travel attributes: An application to international tourists to Kuala Lumpur. *Procedia Soc. Behav. Sci.* **2014**, *144*, 403–411. [\[CrossRef\]](#)
12. Eroglu, S.A.; Karen, K.; Barr, T.F. Perceived retail crowding and shopping satisfaction: The role of shopping values. *J. Bus. Res.* **2005**, *58*, 1146–1153. [\[CrossRef\]](#)
13. Chen, L.Y.; Tan, S.H.; Yang, C.; He, Q.X. Research on the evaluation of urban greenway environmental recreation satisfaction from the perspective of perceived value: A case of Jiulongpo greenway in Chongqing. *Chin. Landsc. Archit.* **2022**, *38*, 76–81.
14. Akama, J.S.; Kieti, D.M. Measuring tourist satisfaction with Kenya’s wildlife safari: A case study of Tsavo West National Park. *Tour. Manag.* **2003**, *24*, 73–81. [\[CrossRef\]](#)
15. Shi, J.L.; Sun, J. Meta-understanding of environmental perception in tourism: Implications for China’s tourist attractions. *Sustainability* **2020**, *12*, 1658. [\[CrossRef\]](#)
16. Ali, F.; Kim, W.G.; Li, J.; Jeon, H.M. Make it delightful: Customers’ experience, satisfaction and loyalty in Malaysian theme parks. *J. Destin. Mark. Manag.* **2016**, *7*, 1–11. [\[CrossRef\]](#)
17. Muslim, H.F.M.; Yahya, N.A.; Numata, S.; Hosaka, T. Ethnic differences in satisfaction with the attractiveness of tropic urban parks. *Sustain. Future Hum. Secur.* **2018**, *10*, 147–159.
18. Lin, Y.B.; Liu, J.; Yu, K.Y.; Ke, Y. Research on perceived evaluation for landscape environmental of treetop walk—A case study of “Fu Forest Trail” in Fuzhou. *Chin. Landsc. Archit.* **2019**, *35*, 72–77.
19. Gold, J.R. *An Introduction to Behavioural Geography*; Oxford University Press: New York, NY, USA, 1980.
20. Burnett, K.P. Behavioural Geography and Philosophy of Mind. In *Spatial Choice and Spatial Behavior*; Golledge, R.G., Rushton, G., Eds.; Ohio State University Press: Columbus, OH, USA, 1976; pp. 23–50.
21. Stokols, D. Environmental psychology. *Annu. Rev. Psychol.* **1978**, *29*, 253–295. [\[CrossRef\]](#)
22. Baker, D.A.; Crompton, J.L. Quality, satisfaction and behavioral intentions. *Ann. Tour. Res.* **2000**, *27*, 785–804. [\[CrossRef\]](#)
23. Zhang, S.J. Research on the lower space of Chongqing riverside viaduct from the perspective of environmental behavior—Taking the space under the Niu jiaotuo bridge as an example. *Chin. Overseas Archit.* **2018**, *10*, 118–121.
24. Deng, W. Using a revised importance-performance analysis approach: The case of Taiwanese hot springs tourism. *Tour. Manag.* **2007**, *28*, 1274–1284. [\[CrossRef\]](#)
25. Kuo, Y.F.; Chen, J.Y.; Deng, W.J. IPA-Kano model: A new tool for categorising and diagnosing service quality attributes. *Total Qual. Manag. Bus. Excell.* **2012**, *23*, 731–748. [\[CrossRef\]](#)
26. Tseng, C.C. An IPA-Kano model for classifying and diagnosing airport service attributes. *Res. Transp. Bus. Manag.* **2020**, *37*, 100499. [\[CrossRef\]](#)
27. Yin, J.; Cao, X.; Huang, X.; Cao, X. Applying the IPA-Kano model to examine environmental correlates of residential satisfaction: A case study of Xi’an. *Habitat Int.* **2016**, *53*, 461–472. [\[CrossRef\]](#)
28. Khaza, M.K.B.; Rahman, M.M.; Harun, F.; Roy, T.K. Accessibility and service quality of public in Khulna city. *J. Urban Plan. Dev.* **2020**, *146*, 04020024. [\[CrossRef\]](#)
29. Park, K. Psychological park accessibility: A systematic literature review of perceptual components affecting park use. *Landsc. Res.* **2016**, *42*, 508–520. [\[CrossRef\]](#)
30. Chen, C.F.; Chen, F.S. Experience quality, perceived value, satisfaction and behavioral intentions for heritage tourists. *Tour. Manag.* **2010**, *31*, 29–35. [\[CrossRef\]](#)
31. Petrick, J.F. The roles of quality, value, and satisfaction in predicting cruise passengers’ behavioral intentions. *J. Travel Res.* **2016**, *42*, 397–407. [\[CrossRef\]](#)
32. Mao, X.G.; Song, J.P.; Feng, W.W.; Zhao, J. Residents recreation satisfaction index of Beijing city parks based on SEM. *Geogr. Res.* **2013**, *32*, 166–178.
33. Hui, T.K.; Wan, D.; Ho, A. Tourists’ satisfaction, recommendation and revisiting Singapore. *Tour. Manag.* **2007**, *28*, 965–975. [\[CrossRef\]](#)
34. Zabkr, V.; Brencic, M.M.; Dmitrovic, T. Modelling perceived quality, visitor satisfaction and behavioural intentions at the destination level. *Tour. Manag.* **2010**, *31*, 537–546. [\[CrossRef\]](#)
35. Cong, L.C. A formative model of the relationship between destination quality, tourist satisfaction and intentional loyalty: An empirical test in Vietnam. *J. Hosp. Tour. Manag.* **2016**, *26*, 50–62. [\[CrossRef\]](#)

36. Hadavi, S.; Kaplan, R. Neighborhood satisfaction and use patterns in urban public outdoor spaces: Multidimensionality and two-way relationships. *Urban For. Urban Green.* **2016**, *19*, 110–122. [[CrossRef](#)]
37. Yu, B.Q.; Che, S.Q.; Xie, C.K.; Tian, S. Understanding Shanghai residents' perception of leisure impact and experience satisfaction of urban community parks: An integrated and IPA method. *Sustainability* **2018**, *10*, 1067. [[CrossRef](#)]
38. Roberts, H.; Kellar, I.; Conner, M.; Gidlow, C.; Kelly, B.; Nieuwenhuijsen, M.; McEachan, R. Associations between park features, park satisfaction and park use in a multi-ethnic deprived urban area. *Urban For. Urban Green.* **2019**, *46*, 126485. [[CrossRef](#)]
39. Chen, K.S.; Chen, H.T. Applying importance–performance analysis with simple regression model and priority indices to assess hotels' service performance. *J. Test. Eval.* **2014**, *42*, 455–466. [[CrossRef](#)]
40. Son, J.W.; Lee, N.; Shin, J.H.; Kim, H. Applying the IPA-Kano model to analysis visiting satisfaction: A case study of natural monument forest of common camellias in Maryang-ri, Seochon. *Korean J. Environ. Ecol.* **2018**, *32*, 532–540. [[CrossRef](#)]
41. Koohsari, M.J.; Mavoa, S.; Villanueva, K.; Sugiyama, T.; Badland, H.; Kaczynski, A.T.; Owen, N.; Giles-Corti, B. Public open space, physical activity, urban design and public health: Concepts, methods and research agenda. *Health Place* **2015**, *33*, 75–82. [[CrossRef](#)]
42. Brown, G.; Schebella, M.F.; Weber, D. Using participatory GIS to measure physical activity and urban park benefits. *Landsc. Urban Plan.* **2014**, *121*, 34–44. [[CrossRef](#)]
43. Tan, X.H.; Peng, Y.L. Scenic beauty evaluation of plant landscape in Yunlong Lake wetland park of Xuzhou City, China. *Arab. J. Geosci.* **2020**, *3*, 701. [[CrossRef](#)]
44. Gulwadi, G.B.; Mishchenko, E.D.; Hallowell, G.; Alves, S.; Kennedy, M. The restorative potential of a university campus: Objective greenness and student perceptions in Turkey and the United States. *Landsc. Urban Plan.* **2019**, *187*, 36–46. [[CrossRef](#)]
45. Pasha, S.; Shepley, M.M. Research note: Physical activity in pediatric healing gardens. *Landsc. Urban Plan.* **2013**, *118*, 53–58. [[CrossRef](#)]
46. Jacopo, G.; Kristian, F.; Martina, L. The use of outdoor microclimate analysis to support decision making process: Case study of Bufalini square in Cesena. *Sustain. Cities Soc.* **2018**, *42*, 206–215.
47. Gozalo, G.R.; Morillas, J.M.B.; González, D.M.; Moraga, P.A. Relationships among satisfaction, noise perception, and use of urban green spaces. *Sci. Total Environ.* **2018**, *624*, 438–450. [[CrossRef](#)] [[PubMed](#)]
48. Sternberg, T.; Viles, H.; Cathersides, A.; Edwards, M. Dust particulate absorption by ivy (*Hedera helix* L.) on historic walls in urban environments. *Sci. Total Environ.* **2010**, *409*, 162–168. [[CrossRef](#)]
49. Escobedo, F.J.; Kroeger, T.; Wagner, J.E. Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. *Environ. Pollut.* **2011**, *159*, 2078–2087. [[CrossRef](#)]
50. Epperly, A.D. Effects of Topography on Near-Roadway Particulate Matter Concentrations and Diesel Emissions. Ph.D. Thesis, West Virginia University, Morgantown, WV, USA, 2018.
51. Zhang, L.; Guo, X.M.; Zhao, T.L.; Gong, S.L.; Xu, X.D.; Li, Y.Q.; Luo, L.; Gui, K.; Wang, H.L.; Zheng, Y.; et al. A modelling study of the terrain effects on haze pollution in the Sichuan Basin. *Atmos. Environ.* **2019**, *196*, 77–85. [[CrossRef](#)]
52. Librett, J.; Henderson, K.; Godbey, G.; Morrow, J.R. An introduction to parks, recreation, and public health: Collaborative frameworks for promoting physical activity. *J. Phys. Act. Health* **2007**, *4*, S1–S13. [[CrossRef](#)]
53. Vailshery, L.S.; Jaganmohan, M.; Nagendra, H. Effect of street trees on microclimate and air pollution in a tropical city. *Urban For. Urban Green.* **2013**, *12*, 408–415. [[CrossRef](#)]
54. Gearey, M. Re-naturing cities: Reducing flood risk through nature-based solutions. *Geography* **2018**, *103*, 105–109. [[CrossRef](#)]
55. Ikin, K.; Beaty, R.M.; Lindenplmayer, D.B.; Knight, E.; Fischer, J.; Manning, A.D. Pocket parks in a compact city: How do birds respond to increasing residential density? *Landsc. Ecol.* **2013**, *28*, 45–56. [[CrossRef](#)]
56. Ekkel, E.D.; de Vries, S. Nearby green space and human health: Evaluating accessibility metrics. *Landsc. Urban Plan.* **2017**, *157*, 214–220. [[CrossRef](#)]
57. Rigolon, A. A complex landscape of inequity in access to urban parks: A literature review. *Landsc. Urban Plan.* **2016**, *153*, 160–169. [[CrossRef](#)]
58. Luo, J.J.; Zhai, S.Y.; Song, G.X.; He, X.X.; Song, H.Q.; Chen, J.; Liu, H.; Feng, Y.K. Assessing Inequity in Green Space Exposure toward a “15-Minute City” in Zhengzhou, China: Using Deep Learning and Urban Big Data. *Int. J. Environ. Res. Public Health* **2022**, *19*, 5798. [[CrossRef](#)]

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.